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CONTRACTOR REPORT ARSCD-CR-81026

A SUMMARY REPORT ON CONTEMPORARY WORLD SMALL ARMS

H. HEVERT
-- R & D ASSOCIATES
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ARLINGTON, VA 22209

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RICHARD VONSCHWEDLER
PROJECT ENGINEER
ARRADCOM

FEBRUARY 1982



US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
FIRE CONTROL AND SMALL CALIBER
WEAPON SYSTEMS LABORATORY
DOVER, NEW JERSEY

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INTRODUCTION

The purpose of this paper is to review the major features of the major contemporary military small arms of the NATO and Warsaw Pact countries and to compare those characteristics which bear on operational effectiveness, such as accuracy, training requirements, rate of fire, round lethality, ammunition weight, weapon weight, reliability and maintainability.

Small arms considered in this report include:

- Personal defense weapon
- Infantry rifle
- Squad automatic weapon
- Light/general-purpose machine gun
- Heavy machine gun
- Sniper rifle
- Submachine gun
- Armor-piercing rifle
- Military shotguns
- Hand-held grenade launchers.

Other weapons which are sometimes categorized as small arms but not discussed herein include:

- Hand grenade
- Light antitank weapon
- Nonlethal devices
- Underwater weapons.

The evolution and the characteristics of modern design approaches for each of these types of weapons will be discussed individually after presentation of a capsule history of the technology of small arms.

SMALL ARMS TECHNOLOGY - A HISTORICAL OVERVIEW

By the end of the 19th century, the basic patents had been granted covering operating principles used in almost all currently fielded small arms. For many categories, practical designs had been developed and were being adopted or under active consideration for adoption by the major world powers.

The Russo-Japanese war of 1904-05 saw the extensive and effective use of rifle-caliber machine guns by both sides. In WWI, machine guns were employed on a vast scale for ground use, aircraft models were introduced, the light squad automatic was developed, and the submachine gun and semiautomatic rifle were introduced in small numbers.

WWII saw the widespread use of semiautomatic rifles and submachine guns. Also by this time, automatic pistols had almost entirely replaced revolvers as the personal defense weapon in the world's armies. Rifle-caliber machine guns had been reduced in weight to improve their mobility as a result of the widespread use of motorized infantry. Heavier caliber machine guns were widely employed on and against armored vehicles and aircraft. The selective fire assault rifle and the intermediate power cartridge were introduced. During this period, many simplified designs using pressed sheet metal parts, investment castings, sintered powdered metal, molded plastics, etc., began to appear.

In the post-WWII era, conventional submachine guns have nearly disappeared from the major modern armies, and the selective fire assault rifle concept has spread worldwide. The use of the intermediate power cartridge in squad automatic weapons was initiated by the Soviets, and the United States is on the verge of doing the same. [The U.S. Army has introduced use of special shoulder-fired grenade-launching

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weapons of 40-mm bore rather than employing adapters on existing rifles for launching grenades. Another type recently becoming popular is the minisubmachine gun, employed as a personal defense weapon replacing the pistol and frequently equipped with a silencer. It is also a favorite terrorist weapon.

Each major industrialized country has to some extent developed its own small arms designs, even though entirely serviceable ones were available for purchase from other countries or for licensed manufacture. The reasons include national pride, economy, adaption to specific requirements, independence from foreign sources, and ^{ADAPTATION} adaption to particular production capabilities. Development has been carried out by private industry to military specifications as was common in Germany, by civil servants in government laboratories as in the USSR and Belgium, or as private corporate or individual efforts later sold to the military. In the United States, a mix of these approaches has been successful.

No single country has proven to be remarkably better than any other in the small arms field, although Germany, the United States and Russia have produced most of the advances in small arms designs in this century. It appears that given adequate resources, talented individuals or small groups are competent to produce effective small arms designs regardless of the political system or other motivation.

In all small arms there are continuing efforts towards reducing the size and weight of weapons and ammunition. This has led to more common use of aluminum and reinforced plastic components in gun designs. Research and development efforts also are underway in attempts to use lightweight materials in cartridges.

PERSONAL DEFENSE WEAPON (see Table 1)

Whether an individual soldier is armed with a .38 revolver or the most sophisticated minimachine pistol is not likely to affect the outcome of any future national conflict, nor in a statistical sense is it likely to alter significantly his chance of survival in a specific combat incident. Nevertheless, it remains an authorized weapon,* second only to the infantry rifle in numbers procured by the Services. The inventory exceeds 500,000.

For 50 years after its adoption, the M1911 .45 pistol was clearly the best even though it was recognized from the beginning that it was a difficult weapon to master. With the appearance of a wide variety of 9 mm pistols, minisubmachine guns and machine pistols, the superiority of the .45 is no longer clear. The higher volumes of fire and capabilities of these weapons tend to compensate for the skill required to shoot accurately with the conventional pistol.

It has been demonstrated that a highly skilled individual can be deadly at 100 m with a .45 automatic; however, such skill is expensive and time-consuming to acquire and maintain. The problem of skill development would be eased by transition to a 9 mm pistol, especially for the increasing numbers of women in the armed forces.

The mini-SMG represents another possibility for offsetting poor shooter skill. In this case, the higher volume of fire would compensate for inaccuracy. Whether it should be configured with a holster/stock, folding wire stock, or stockless is not clear, but can be determined through objective user testing of existing designs. Larger calibers, possibly using multiple projectile cartridge systems such as the Salvo Squeezebore,

*In the United States, the handgun is issued as standard equipment in order to simplify the logistics of ammunition procurement. In some countries' armies, handguns and ammunition are procured personally by individuals.

TABLE 1. COMPARISON OF PERSONAL DEFENSE WEAPONS

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
U.S.	Automatic pistol, cal. .45 M1911 and M1911A1	1911 to present	Semiauto, magazine fed, 7-shots	Excellent stopping power, reliable, durable	Short effective range, hard to learn to fire accurately due to heavy recoil and noise	Low V_0 of cartridge is ideal for use with silencer though none fitted	As good as any conventional pistol and better than most. Multiple projectiles (3) cartridges developed which provide improved hit probability but at sacrifice in stopping power.
	Carbines, cal. .30, M1, M2, M3	WWII, Korea, Vietnam	Magazine fed (15- or 30-rounds) M1 is semiauto only; M2 is selective fire; M3 has infrared telescopic sight	Effective range ~200 m light (2.5 kg) and short (0.9 m) compared to conventional rifles of the period	Marginal reliability under adverse conditions	Folding paratrooper stock available	Developed in 1940-41 as a replacement for the .45 pistol; it did not replace the pistol to any significant extent but was widely issued (~6.5 million produced) to replace both rifles and submarine guns. Still in use throughout the world except by U.S. forces.
	MAC 11 submachine gun, cal. .380	1971 to present	Selective fire machine pistol, 32-round magazine folding wire stock, accessory silencer, 1.5 kg weight	Can be fired with one hand as a pistol, or from shoulder or hip as submachine gun. Very efficient silencer	Very hard to shoot accurately in any mode	Silencer	High dispersion; however, a 9-round burst is equivalent to a single 12-gauge 00 buckshot salvo. Each magazine contains three such bursts in a weapon 1/3 the size and weight of a shotgun.
	USAF survival rifle, cal. .221 "stockless" rifle "IMP"	Developed ~1970, not issued	Selective fire, magazine fed (30-round) weapon, has pistol grip near muzzle and lies along top of forearm to elbow joint	Effective to ~200 m when fired with arm extended and elbow support from other arm	Excessive blast and flash from short barrel for powerful cartridge used	Three sets of sights for right- or left-arm fire or as pistol, 3-shot burst limiter	Can be fired from hip like a submachine gun. Similar commercially available .223-cal weapon called the bushmaster is unreliable and even more excessively noisy. The "stockless" concept appears worthy of further development.

TABLE 1. (CONTINUED)

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
U.S.	Sidewinder submachine gun, 9 mm or cal. .45	Development	Conventional zine/fed sub-machine gun, except pistol grip near front as in USAF "stockless," ~2 kg in 9 mm	Lighter and shorter than conventional submachine guns, due to elimination of stock; accurate to ~100 m in extended arm mode		Pistol grip pivots radially so magazine may be placed in optimum location to match firing position. Selective fire progressive trigger.	The "stockless" concept appears worthy of further development on submachine guns.
	Gyrojet pistol, Mark I, 13 mm	Introduced 1965, now obsolete	Semiauto rocket launcher in pistol configuration, 5-shot capacity	Cheap and simple, insignificant recoil, considerable power at rocket turnout (~20 m)	Inaccurate, insufficient power below 5-m range, excessive ammunition cost due to complex spin-stabilized multiple nozzle rocket	A launcher in submachine gun configuration was developed.	It was possible for a potential target at ~0 range to hold the rocket in the launcher, whereupon the exhaust could burn the hand of the firer. Concept was novel but does not appear competitive with conventional cartridge weapons.
S.U.	Automatic pistol, 7.62 mm TT 33 (Tokarev)	1933 to 1950s	Semiauto magazine fed, 8 shots	Simple, reliable, compact for its power	Short, effective range, poor pointing, no manual safety	Modular hammer/rear assembly	Undistinguished design probably reflects lack of importance of pistol in Soviet doctrine of period.
	Automatic pistol, 9x18 mm PM (Makarov)	1951 to present	Semiauto magazine fed, 8-shots double action trigger	Simple, reliable safe to carry	Marginal power and accuracy		Similar to and evolved from German Walther PP of 1929. Marginal power by U.S. standards.
	Machine pistol, 9x18 mm APS (Stechkin)	1951 to present	Selective fire pistol with detachable hollow plastic buttstock/holster, 20-round magazine	Accurate in semi-auto mode to ~100 m	Large and clumsy pistol for its power	Has rate-reducing device in full auto mode	Probably intended to replace submachine gun (now obsolete in Soviet Army), but folding stock AK and AKM are more common. Issued to tank crews and some officers. Obsolete.

TABLE 1. (CONCLUDED)

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
Belgium	Automatic pistol, 9x19 mm M1935 Browning HP	1935 to present	Semiauto magazine fed, 13-rounds	Large magazine capacity, adequate power, reliable and durable	Short effective range	Magazine safety	Most common military pistol of Western nations.
U.S., Italy, Czech	Smith & Wesson 59, Beretta M92S, CZ M1975 (A11 9x19 mm)	Current	Similar to above Browning, but double action trigger	Large magazine capacity, adequate power, reliable and durable	Short effective range	Double-action trigger increases first shot safety and readiness	Current state of art in conventional auto pistols.
Czech	Machine pistol, M1961, 7.65, (Scorpion)	1961 to present	Similar to U.S. MAC 11	Similar to U.S. MAC 11	Similar to U.S. MAC 11	Silencer, rate reducer	Same as MAC 11.
Poland	MP EZ263, 9x19 mm	1963 to present	Similar to U.S. MAC 11	Similar to U.S. MAC 11	Similar to U.S. MAC 11	Compensator, rate reducer	Same as MAC 11.
West Germany	Machine pistol, Heckler & Koch, 9x19 mm VP-70	1970 to present	Selective semiauto as pistol, 3-round burst with plastic stock attached	Large (18) magazine capacity, adequate power, accurate to ~100 m with stock attached	Rather large for a pistol, long and heavy trigger pull	Burst control is in stock	3-round burst feature conserves ammunition. Simplest pistol made.

could produce short bursts whose terminal effects and patterns resemble 12 gauge 00 buckshot blasts, but with longer range potential.

It should be recognized that relatively minor improvements in personal body armor could significantly reduce the effectiveness of any of the weapons discussed, except possibly the USAF stockless rifle. In this event, the personal defense weapon should become the assault rifle, and refinement to reduce weight and size would become a priority task.

INFANTRY RIFLE (see Table 2)

Despite development of functional semiautomatic rifles as early as the 1890s, the United States and the Soviet Union were the only nations that had adopted and fielded significant quantities by the start of WWII. The U.S. M1 Garand was highly successful; the Soviet Tokarevs proved to be too frail in service and were withdrawn. Post-WWII semiautomatics included the Soviet SKS, the U.S. M14, and the Belgian FN-FAL.

The German STG 44 appeared in insufficient numbers and too late in WWII to have great effect but profoundly impressed all those who had to oppose it.* The U.S. M16 and Soviet AKM both represent further development of the same concept which became known as the assault rifle. Experience had shown that the full power cartridges used in machine guns had more energy than needed for rifles where 95 percent of targets were engaged at ranges less than 300 m. The intermediate power cartridges used in assault rifles (i.e., less power than machine gun rounds but greater than submachine gun or pistol rounds) permitted smaller and lighter weapons and cartridges. The

*It is interesting to note in passing that Costa Rica had adopted a selective fire assault rifle in the mid-1930s. This was the Italian Beretta model PG. It was very advanced for its day, having such features as a burst limiter.

TABLE 2. COMPARISON OF INFANTRY RIFLES

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
U.S.	U.S. rifle, cal .30 M1 (Garand)	WWII and Korea	Semiauto, gas piston operated, fed by 8-round	Reliable, durable accurate to 600 m	Bulky, limited capacity, could not be reloaded when partially empty	Automatic pressure relief valve firing grenades	Adopted 1936; over 6 million manufactured. Standard U.S. infantry rifle of WWII. Selective fire versions using BAR .20-round box magazine made in experimental quantities during and after WWII, but not adopted. Some converted to 7.62 NATO cartridge and used into 1960s.
	U.S. rifle, 7.62 mm M14	1957 to present	Selective fire, gas operated, 20-round box magazine	Reliable, durable, accurate to 600 m	Not controllable in full auto fire due to high recoil	Auxiliary bipod M2 5-slot flash hider provides some climb compensation, hinged, butt plate, chrome-lined barrel	1,380,000 produced through 1963 when production ceased. Standard rifle usually issued without full auto switch. M14E2 version has straight line stock and two pistol grips for improved full auto performance. Served as squad auto weapon.
	U.S. rifle, 5.56 mm M16 and M16A1 (aka AR15)	1962 (USAF), 1963 (USA) to present	Selective fire, gas operated, 30-round box magazine, extensive use of aluminum and plastic parts gas piped direct to bolt, no piston rod	Very light, compact, relatively easy to control in full auto fire, accurate to 400 m in semiauto mode	Somewhat dirt-sensitive, trigger group lacks AP capability, trace range marginal	Auxiliary bipod positive bolt, closer device on M16A1 (Army) version only, carrying handle	Initial problems with this rifle in Vietnam have largely been resolved by addition of chrome-lined barrel-improved buffer, improved propellant in cartridge, and better user training. Over 4.5 million manufactured. A submachine gun version designated XM177E2 has a telescoping stock and 11.5-inch barrel.
	AAI SPIW rifle, 5.56 mm flechette	Exper. 1963-1973	Selective fire primer piston operation, 60-round, drum-fed	Minimal dispersion of 3-round bursts due to low recoil impulse and high cycle rate, very light (-6 lb)	Very complex trigger group and magazine, overheating parts, breakage, excessive noise and flash	Fire selector had following modes: semi-auto, 3-round burst (2000/min), full auto (500/min); grenade launcher	Designed to fire flechettes primarily in 3-round burst mode. This design, the best among four competing SPIW concepts, was unsuccessful due to functional problems, e.g., broken parts, overheating.

TABLE 2. (CONTINUED)

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
S.U.	SKS-46 carbine, 7.62x39 mm	1946 to present	Semiauto, gas piston operated, tilt bolt, 10-round fixed box magazine	Light, accurate to 300 m	Lack of full auto capability, limited mag. capacity	Folding bayonet	Tactical equivalent of U.S. M1 or M14 but employing M1943 intermediate power cartridge. The AK proved more compatible with Soviet tactics, so the SKS is obsolescent.
	AK-47 and AKM, 7.62x39 mm	1947 to present	Selective fire, gas piston operated, 30-round box magazine	Reliable and durable even in adverse environments, accurate to 300 m in semi-auto mode, fairly controllable in full auto	Marginal AP capability	Folding stock version, muzzle compensator on AKM	AKM versions have stamped receiver to reduce weight and cost, also rate reducer for full auto mode. Widely made and used in all Communist bloc countries. Folding stock version has replaced submarine guns. 5.6-mm versions reported as AK74S.
	Tokarev M1938 and M1940, 7.62x54R	WWII early	Semiauto, gas piston operated, tilt bolt, 10-round box magazine	Relatively light, accurate to 600 m	Unreliable, functioning, parts breakage	Muzzle brake, fluted chamber	This weapon proved unreliable in the war with Finland and was little used in WWII. As a result, the Soviet Army used M1891 bolt action rifles and very large numbers of submachine guns instead.
Belgium	FN-FAL, 7.62x51 mm NATO	1957 to present	Selective fire, gas piston operated 20-round box magazine	Reliable, durable, accurate to 600 m in semiauto mode	Not controllable in full auto fire due to high recoil, heavy (~5 kg) dirt-sensitive	Folding bipod, folding stock, and folding carrying handle available	Developed contemporaneous with U.S. M14. Widely used throughout world including British Commonwealth nations. Not all have the full auto fire features.
West Germany	Heckler and Koch G-3 (aka HK41 and HK91), 7.62x51 mm NATO	1959 to present	Selective fire, retarded blowback, 20-round box magazine	Reliable, durable, accurate to 600 m in semiauto mode	Not controllable in full auto fire due to high recoil, heavy (~5 kg)	Folding bipod, folding stock, and folding carrying handle available	Widely used throughout world.
	Heckler and Koch HK33, 5.56x45 mm	1968 to present	Selective fire, retarded blowback, 25-round box magazine, "Bull Pup" stock config	Similar to U.S. M16 but heavier	Same as U.S. M16, fluted chamber must be kept clean	Same as G-3	Adopted by several smaller under countries and produced under license.

TABLE 2. (CONCLUDED)

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
France	MAS, 5.56x45 mm	1977 to present	Selective fire, retarded blow-back, 25-round box magazine, "Bull Pup" stock config.	Short due to stock design, easy to control, has 3-shot burst limiter	Insufficient experience to reveal	Parts reversible to allow gun to be fired left-handed, carrying handle	First European country to convert to 5.56 mm. "Bull Pup" design unconventional but may prove popular; the 19th century concept.
U.K.	Individual weapon 4.85x49 mm	1976 experimental	Selective fire, retarded blow-back, 25-round box magazine, "Bull Pup" stock config.	Short, easy to control	Insufficient experience to reveal	Nonmagnifying optical sight	U.K. has favored "Bull Pup" stock concept since EM-2 rifle, ~1950
Nazi Germany	Assault rifle, STG 44 (aka MP43), 7.92x33 mm	1943 to 1945	Selective fire, gas piston operated, 20-round box magazine	Accurate in full auto fire due to straight stock, extra low rate, and moderate recoil impulse	Heavy (~4.5 kg)	Unusually long bolt stroke gave rate of 450/min, "Kummerlauf" 30° bent barrel attachment for firing from foxholes, used prismatic sight	Earliest "assault" rifle achieving widespread use. It had a far-reaching effect on post-WWII rifle development.

lower impulse allowed improved accuracy in burst fire and reduced user fatigue.

The assault rifle concept is firmly established, and current efforts are directed at weight and size reduction. Calibers below 5.56 mm have been tried but have not been found acceptable in terms of lethality, tracer range, or penetration capability. Reduction in cost of manufacture has been achieved in many cases through modern methods of pressing and casting, without any sacrifice in quality. Assault rifles have replaced submachine guns in the more modern armies because they provide greatly improved performance at little sacrifice in weight and size, although cost is much higher.

Both the M16 and AKM are adequate rifles and are likely to remain in service for many years to come, despite ongoing R&D in the U.S. and the emergence of the AK-74 in the USSR. The M16 is lighter and is generally regarded as easier to shoot effectively than the AKM. The AKM is a more rugged mechanism and more reliable in hostile environments such as mud or dust. Various mechanical improvements to the M16 are currently being evaluated by the Marine Corps and the Army. The more significant ones include a heavier barrel to enhance durability, increased twist to accommodate a higher-performance bullet, and a burst control device. One promising product improvement that appeared to be near perfection when R&D was discontinued was the use of aluminum cartridge cases for weight reduction. Caseless cartridges and liquid propellant guns could further reduce ammunition weight but do not appear within present state of technology for fielded systems.

The gap between the rifle and the squad automatic weapon is now very small, the major difference being belt feed on the squad automatic weapon vs magazine on the rifle. This

suggests that the squad automatic weapon might replace the rifle, providing each infantry man with far more firepower at a minor weight penalty.

SQUAD AUTOMATIC WEAPON (see Table 3)

The BAR, which was developed during WWI but not used in quantity until WWII, was the first U.S. squad automatic weapon. It was excessively heavy and powerful for this role but was employed through the Korean War. Both the U.S. M1941 Johnson and the German FG42 were far superior guns used in a very limited way in WWII, but they also were too powerful for the purpose.

In the late 1960s and early 1970s, a squad automatic weapon was developed in 6 mm, but the concept was unacceptable because the cartridge was different from both the rifle and machine gun. The current U.S. Army requirement for the squad automatic weapon is essentially a belt-fed automatic rifle firing a cartridge effective to 800 m and weighing not more than 10 kg with 200 rounds.

The technology has existed to build such a gun in 5.56 mm for many years. Recent ammunition improvements in this caliber appear to provide marginally adequately effectiveness, allowing a common caliber with the rifle, in practice a necessary condition.

The Soviet Union has had close to a squad automatic weapon capability for over 30 years, but has gone from the belt-fed RPD to the magazine or drum-fed RPK firing closed bolt and with no barrel change. This apparent retrogression may be a result of a desire for commonality of design with the rifle.

TABLE 3. COMPARISON OF SQUAD AUTOMATIC WEAPONS

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
U.S.	Browning automatic rifle, cal .30 M1918A2 (BAR)	1918 to 1960	Gas operated, selective fire from open bolt, 20-round box magazine	Reliable, accurate in semiauto mode	Low effective rate of fire due to small magazine, heavy recoil, lack of barrel change capability, excessive dispersion without bipod	Folding bipod, flash hider, some models had 2 selectable auto rates (300/600) instead of semi and full, gas regulator	Some were converted to 7.62 NATO, some foreign versions had barrel change.
	Johnson light machine gun, M1941 (and 1945)	WWII	Recoil operated, selective fire, semiauto from closed, full from open, 20-round box magazine	Very light for its performance due to closed bolt in semi; more accurate than BAR full line stock, quick barrel change	Single column side magazine was awkward ^{USING} during 5-round chargers, folding bipod, folding sight	Could be loaded thru port in right-hand side during 5-round chargers, folding bipod, folding sight	Outstanding for its time, used by Army Rangers in Italy and by marine raiders, a gas-assisted version with belt feed was under development at end of WWII when interest died. Excessive power for squad automatic weapon.
	7.62 mm rifle, M14E2 (M14A1)	1957 to present	An M14 rifle with straight line stock, bipod and compensator to minimize full auto dispersion.	Lighter than BAR	Overheating due to light barrel and closed bolt -bolt firing	Detachable compensator	A rather unsatisfactory makeshift, excessive power for squad automatic weapon.
	Stoner 63 machine gun, 5.56 mm (and 63A)	1963 to present	Gas operated, fully auto from open bolt, 100-round belt in box under receiver	Light, accurate, quick change barrel allows sustained fire	Limited effective range for machine gun	Part of a system in which same basic mechanism is used in rifle, light machine gun and mounted machine gun configurations.	Limited use in Vietnam by Army and Navy.
	6 mm squad automatic weapons, three types: Ford (Moremont) Rodman	Developed 1970-1972	Gas operated, fully auto from open bolt, 100-round belt in box under receiver	Light, accurate, quick change barrel allows sustained fire	Cartridge not same as either rifle or machine	6x45 cartridge, $V_0 = 750$ m/s, $W_B = 6.8$ gm (105 grain)	Bullet traces and will pierce helmet to ~800 m.

TABLE 3. (CONCLUDED)

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
U.S.	5.56 mm squad, Rodman (XM248)	Developed 1972-1974	As above, but has 100- or 200-round belt box	Light, accurate, quick change barrel allows sustained fire	Limited effective range of machine gun	Straight line stock, soft buffer, and gas system minimize dispersion	New ball (XM287) will pierce helmet at 800 m, new tracer (XM288) will trace to near 800 m, both compatible with M16 rifle.
S.U. <i>Strelkov</i>	<i>Degtyrev</i> machine gun, DP, DPM 7.62x54R	1926 to 1950	Gas operated, fully auto from open bolt, bipod mounted, 47-round pan magazine	Reliable, barrel changeable with some difficulty	DP had spring problems cured in DPM, too heavy, drums slow to load and clumsy to carry, dirt-sensitive	Dual flap locking system	Tank and aircraft versions were similar, excessive power for squad automatic weapon.
<i>Strelkov</i>	<i>Degtyrev</i> RPU, 7.62x59	1946 to 1960	Gas operated, fully auto from open bolt, bipod mounted, 100-round belt in drum under gun	Relatively light, accurate	Marginal power made gun dirt-sensitive	Dual flap locking	Obsolescent, replaced by RPK and PK, still widely used in satellite countries.
	Kalashnikov RPK, 7.62x59	1964 to present	Gas operated, selective fire from closed bolt, 30-(AK) and 40-round box magazine or 75-round drum, bipod mounted	Light	Overheating due to light barrel and closed bolt firing mode, no barrel change		Essentially an AK with heavy barrel and bipod. It lacks the sustained fire capability of RPD. Evidently Soviets don't feel pressing need for belt-fed squad automatic weapon.
Belgium	FN-MIHIM (XM249) 5.56x45 mm	Developed 1974	Gas operated, full auto open bolt, 100- or 200-round belt in box under gun or M-16 box magazine	Light, accurate, quick change barrel allows sustained fire	Limited effective range of machine gun	Use of belt or magazine-fed	Contender for U.S. squad automatic weapon.
(Nazi) Germany	FG-42, 7.92x57 mm	1942 to 1945	Gas operated, 20-round box magazine from left-hand side, semiauto closed bolt, full auto bolt	Very light for performance, accurate due to straight stock and soft buffer	Overheating due to light barrel, no barrel change	Bipod, flash hider/compensator	Outstanding for its time, excessive power for squad automatic weapon.
West Germany	Heckler and Koch 23 A1, 5.56x45 mm	1973 to present	Retarded blow-back, selective fire, closed bolt, belt-fed	Quick change barrel, simple, easy to insert, belt	Overheating due to closed bolt fire	Fluted chamber	Essentially similar to all other HK rifles and machine guns, in wide use throughout world.

LIGHT MACHINE GUN/GENERAL-PURPOSE MACHINE GUN
(see Tables 4 and 5)

Historically, the trend has been to have the light machine gun and the general-purpose machine gun be the same basic gun, having the former bipod-mounted and the latter tripod-mounted. Many adequate guns exist, but the German MG-42 appears best.

It is possible to improve on the basic gun principally through weight reduction. Weight reductions of 25 to 50 percent can be achieved by use of aluminum, beryllium and plastics in all parts except bolts, barrels, sears, and extractors. The weight saved can be used to make the guns more portable or reallocated to the barrel to increase the sustained firing capability.

Much remains to be done in the field of tripod mounts and accessories. Searching fire should be re-examined as an area-denial technique. For example, it is technically possible to provide an electronic device to control a suitably mounted gun firing apparently randomly into an area. The device would select times to fire, burst length, elevation and deflection. Servos and solenoids on the mount would do the work. A single gunner could serve several weapons, his only duties being changing belts and barrels, and clearing stoppages.

The use of laser rangefinders, plus telescopic sights developed for sniper rifles, could make 2000-m sniping a reality when firing the guns from the rigid tripod mount.

HEAVY MACHINE GUN (HMG) (see Table 6)

Through WWII, the typical machine gun was a heavy water-cooled weapon of rifle caliber mounted on a sturdy tripod mount. During that conflict, lighter versions were developed using air-cooled barrels and bipods. By WWII, these older

No so. Light weight versions were developed in 1919 and 1923

TABLE 4. COMPARISON OF LIGHT MACHINE GUNS

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
U.S.	Browning machine gun, M1919A6, cal .30-06	WWII and Korea	Recoil operated, belt fed, bipod mounted, screwout barrel change with headspacing req.	Reliable	Limited volume of fire due to slow and awkward barrel change, heavy		A WWII expedient, modified from basic tripod-mounted gun by use of lighter barrel and adding buttstock.
	M60 machine gun, 7.62 mm NATO	1957 to present	Gas operated, belt fed, bipod mounted, quick change barrel	Reliable, high volume of fire	Rather heavy	Stellite-lined barrel reduces need for barrel changes	Design is a combination of features from German WWI FG-42 and MG-42.
S.U.	(UP and DPM) machine gun, 7.62x54R	1933 thru WWI	Gas operated, 47-round, overhead pan fed, bipod mounted, barrel change requires wrench	Simple	Dirt-sensitive, pan feed awkward, frail, overheated		Was really intended to be a squad automatic weapon but was too heavy and limited in volume of fire for light machine gun.
	RP 46 company machine gun	1946 to 1960	Gas operated, belt or pan fed, bipod mounted, quick change barrel	High volume of fire	Complex, dirt-sensitive		Essentially a belt-fed UP, the rimmed round imposes a complex feed cycle, never widely used.
U.K.	PK and PKM light machine gun, 7.62x54R	1964 to present	Gas operated, belt fed, bipod or tripod mounted, barrel change	High volume of fire, light	Rather involved barrel change, complicated to load belt into gun	Chrome-lined barrel	Kalashnikov design, complex belt feed due to rimmed round with pull-out then push feed cycle.
	Bren light machine gun, cal .303	1939 to 1960	Gas operated, 30-round mag. on top, bipod or tripod mounted, quick change barrel	Reliable, accurate	Rather heavy, limited volume of fire due to magazine feed	200-round drum available for AA use on tripod, selective fire	Many later converted to 7.62 NATO; some still in use by auxiliary units.

TABLE 4. (CONCLUDED)

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
Germany	MG-42 (MG3), 7.92x57 or 7.62x51 NATO	1942 to present	Recoil operated, belt fed, bipod or tripod mounted, quick barrel change	High volume of fire, easy barrel change	Difficult to master due to high cycle rate	Extensive use of stamped parts, gas booster for barrel beyond muzzle	easily the best light machine gun of WWII. Still in use throughout world including Italy and Yugoslavia. Latest versions have dual rate of fire.
	Heckler and Koch HK21 and 21A1, 7.62x51 NATO		Retarded blow-back, belt fed, bipod or tripod mounted, quick barrel change	High volume of fire, easy barrel change, very light	Retarded blow-back operation requires fluted chamber so gun is dirt- and ammo-quality-sensitive	Alternate magazine feed available, selective fire	Gun fires closed bolt so cook-off hazard present unless barrel is changed when hot.
Belgium <i>called</i>	FN-MAG, cal 7.62x51 NATO, (cal) L7A2 in U.K.	Late 1950's to present	Gas operated, belt fed, bipod or tripod mounted, quick barrel change	Reliable, high volume of fire	Rather heavy	General excellence of manufacture and design details	Widely in use including U.K. Recently adopted by U.S. for vehicular applications replacing M73. <i>4/12/79</i>
Czech	V2 5A, 7.62x54R	1959 to present	Gas operated, belt fed, bipod or tripod mounted, quick barrel change	High volume of fire	Bipod is on barrel and <i>AC</i> must be switched as part of changing barrel	Open pocket link allows push feed of rimmed round	Feed simpler than Soviet PK due to better link, since commonality with medium machine gun not required.

TABLE 5. COMPARISON OF GENERAL-PURPOSE MACHINE GUNS

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
U.S.	Browning machine gun M1919A4, cal 30, tripod M2	WWII and Korea	Recoil operated, belt fed, simple tripod with T&E mech	Reliable	Heavy due to very heavy barrel to allow sustained fire. No AA capability on tripod	Barrel changing requires stripping gun and adjusting headspace after reassembly	Gun fires closed bolt, leading to cookoff problems.
	Machine gun M60, 7.62x51 NATO, on tripod M122	1957 to present	Gas operated, belt fed, quick change barrel, simple tripod with T&E mech	Reliable, high volume of fire	No AA capability on tripod	Stellite-lined barrel reduces need for barrel changes	
S.U.	Goryunov machine gun SG43 and SGM, 7.62x54R, on wheeled tripod	1943 to 1960	Gas operated, belt fed, quick change barrel, tripod conv. to AA position	High volume of fire, gun could be towed on wheels while mounted	Wheeled mount not suited to rough terrain	Shield on mount of some guns to protect gunner	A simple tripod mount with T&E mech was also issued. Obsolete in Soviet Army; still widely used in satellite countries.
	Machine gun PKS and PKMS, 7.62x54R	1964 to present	Gas operated, belt fed, changeable barrel, tripod conv. to AA position	High volume of fire, light weight, chrome-lined barrel	Slow barrel change		
West Germany	MG42 (and MG3) 7.92x57 or 7.62x51 NATO	1942 to present	Recoil operated, belt fed, quick change barrel, complex tripod with high and low positions, automatic searching mode	High volume of fire, accuracy from stable tripod with buffer	No AA capability on tripod (but a separate AA tripod is issued)	Optical sight on tripod, auto search mode on tripod, tripod, dual rate of fire	Very flexible weapon and widely issued.

TABLE 5. (CONCLUDED)

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
West Germany	Heckler and Koch HK21 and HK21A1 on tripod 1100 7.62x51 NATO	1968 to present	Retarded blowback, belt fed, quick change barrel, tripod with traverse and searching mode	High volume of fire	No AA capacity on tripod but a separate AA tripod is issued). Gun fires closed bolt leading to cookoff problems unless barrel is changed when hot	Periscopic sight on tripod, auto search mode, selective fire, alternate magazine feed.	Very flexible weapon and widely issued.
Belgium	FN-MAG, 7.62x51 NATO	Late 1950's to present	Gas operated, belt fed, quick change barrel, tripod with recoil buffer	High volume of fire	No AA capability on tripod	Buttstock ¹ removed when used on tripod	Widely used through the world, including UK, Argentina, Israel, India.
China (PRC)	Machine gun, Type 67 7.62x54R	1967 to present	Gas operated, belt fed, quick change barrel, tripod conv. to AA position	High volume of fire		User ⁵ push thru link with rimmed round like Czech light machine gun	Although the PKC has usually used its cuples of Soviet small arms, it apparently did not accept the complex feed of the PK and designed its own gun instead.

TABLE 6. COMPARISON OF HEAVY MACHINE GUNS

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
U.S.	Browning machine gun, cal .30 M1917A1	WWI and WWII	Recoil operated, belt fed, water cooled, heavy tripod mount	Sustained fire due to water cooling	Need for water, excessive weight		Developed too late for much use in WWI, widely used in WWII in defensive role, now obsolete.
	Browning machine gun, cal .50 M2	1930s to present	Recoil operated, belt fed, barrel length/weight and mount to suit self application, disintegrating belt	Reliable, flexible. Variations to basic gun exist for fixed aircraft, flexible aircraft, ground tripod, antiaircraft (air or water cooled), aircraft high rate (M3), etc.	Long receiver, closed bolt firing causes cookoff hazard, overhead clearance required to open cover for loading is problem in a tank, slow barrel change	Feed reversible right or left side by rearranging parts. Stillite-lined and chrome-plated barrel allows long bursts	One of the most successful designs ever created. The standard U.S. aircraft machine gun of WWI & Korea. Still widely used on armored vehicles throughout the world. A variety of accessories were developed and also many types of tracer, incendiary and armor piercing ammunition. A salvo squeezebore round round with 5 projectiles and a DU flechette were developed but not issued.
S.U.	Maxim 1910 machine gun, 7.62x54R	WWI and WWII	Recoil operated, with gas boost at muzzle, belt fed, water cooled	Sustained fire due to water cooling	Need for water, excessive weight	Wheeled mount to improve portability, armored shield on mount	Widely used in WWI, made in quantity as late as 1944, now obsolete.
	DSHK-38/46 12.7 mm	1938 to present	Gas operated, belt fed, using 50-round metallic link belt, quick change barrel, tripod, wheeled mount, AA mount, or vehicle mount	Reliable, flexible, fires open bolt fur cooling	Dirty-sensitive	Feed reversible right or left side by rearranging parts	Mostly used in vehicle applications; i.e., APCs and tanks by Soviets. Used in ground applications by Asian Communist forces.
U.K.	KPV Heavy machine gun, 14.5 mm	1949 to present	Recoil operated with gas boost, belt fed, quick change barrel vehicular and AA mounts	Greater AP capability than .50 guns using AP1 round. Excellent AA capability using HEIT round	Complex load and unload procedure	Feed reversible right or left side by rearranging parts, chrome-lined barrel	The cartridge was developed for antitank rifles in the 1930s, and these were effective against light German armor of the day. The round is effective against APCs to today. No comparable U.S. size.
	BESA machine PK1, 15 mm	WWII	Gas operated, belt fed, selective fire vehicle mount	Greater AP capability than .50 guns	Size and weight compared to .50 BMG		Used on armored cars in WWI to limited extent. Later used by Israel. A Czech design licensed to U.K.

guns were called heavy machine guns. They remained in production through WWII despite the more widespread use of portable lighter guns. They are now considered obsolete, and the term "heavy machine gun" is more commonly applied to guns in the 12.7- to 15-mm caliber range.

The heavy (12.7-mm) machine gun was used in WWII primarily as an antiarmor/antiaircraft weapon. Aircraft versions of some were highly successful, particularly the .50 Browning which was easily the best aircraft machine gun of WWII and still is used widely on armored vehicles in a heavy barreled version.

Improvements that would benefit in the HMG are more range and AP capability plus a multiple feed system to instantly select the type of projectile to be fired. Other desirable features are a rearward barrel change, no need to open covers for loading belts, semi-auto mode, and solenoid firing option without interfering with the manual trigger. No fielded gun has all these features, but they are feasible.

The Soviets have built larger guns than ours (14.5 mm) in order to achieve more range and penetration. Indeed, their 12.7 guns outperform the .50 Browning machine gun at some penalty in size and weight. Consequently, the 20 mm or even 25 mm has been considered for many heavy machine gun applications, but these guns are even larger and heavier, and more difficult to mount due to heavy recoil.

As an alternative, many improved types of .50 armor piercing rounds have been developed since WWII, in the United States, Canada, and the Netherlands. Potentially most potent was the hypervelocity depleted uranium flechette developed at TRW in 1970, but this project was terminated before adequate accuracy and reliability were achieved.

Incendiary and tracer capability are vital for this size ammunition since primary targets are light armor vehicles and aircraft. HE would also be desirable in the larger calibers if fuzing costs can be kept low enough.

SNIPER RIFLE (see Table 7)

A sniper rifle in the hands of a skilled marksman can be a very efficient weapon. The ratio of shots fired to casualties produced is orders of magnitude higher than for any other small arm. The main reason for the limited issue and use is the high level of training required to realize its potential.

The Soviets are reported to have made wide use of highly trained snipers in WWII, with good effect. Their current Dragunov sniper rifle is indicative of continuing interest in this class of weapon.

The U.S. M14 has been considered, because of its mechanical and ballistic characteristics, as the basis for a sniper's weapon. The existing ART telescopic sight is better than known foreign equipment, but it lacks nighttime capability and the ranging system is marginal.

The technology exists to make a night sight (starlite scope) and to build-in a laser rangefinder. Whether it can be made small, light, rugged and cheap enough to be practical is not clear.

SUBMACHINE GUN (see Table 8)

Desirable characteristics of a submachine gun include compactness, light weight, 200-m effective range, and ability to be silenced.

The role of the submachine gun in modern armies has greatly diminished since WWII due to emergence of assault rifles firing intermediate power cartridges such as 7.62x39

TABLE 7. COMPARISON OF SNIPER RIFLES

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
U.S.	U.S. rifle, cal .30 M1903-A4	WWI	Bolt action, 5-shot 2.5X telescopic sight (Weaver 300 C) or 2.75X (Lyman Alaskan)	Simple	Commercial telescope lacking calibration for range, scope size inadequate for dim light	Lack of metallic sights	A wartime expedient, little better in experienced hands than a standard rifle, probably even inferior at long range because of poor adjustment features.
U.S.	U.S. rifle, cal .30 MIC and M10	WWI & Korea	Semiauto, 8-round, 3-X scope (M84) with range calibration to 600 yd	Standard peep sight also usable, semi-auto operation minimizes manipulation to reduce sniper detection	Scope offset to left to permit loading made aiming awkward, scope inadequate for dim light	Lace-on leather cheek rest, auxiliary flash hider	Adequate for time period.
U.S.	U.S. rifle, 7.62 mm M21 (M14 type)	Used in Vietnam as XM21, standardized 1975	Semiauto, 20-round box magazine, 3-9X scope with range-finding reticle coupled to range adjustment up to 900 m	Reasonably accurate, range estimation with simultaneous adjustment gives high first-shot hit probability and allows engaging fleet-ing targets	Scope must be removed to use peep sight, lack of reticle illumination	Rifle accepts M2 bipod. Issued with and calibrated for match ammunition.	A very effective weapon in well-trained hands.
S.U.	M1891/30 sniper rifle, 7.62x54R	WWI	Bolt action, 5-shot ~3X scope calibrated to 1300 m	Simple, open sight usable without removing scope	Scope size inadequate for dim light		Widely used in WWI.
S.U.	M1938 and M1940 sniper rifle, 7.62x54R	WWI	Semiauto, 10-round box magazine, ~3X telescope calibrated	Same as U.S. M10	Scope size inadequate for dim light		The mechanical shortcomings of this rifle were minimal for a sniping rifle where better care, maintenance and ammunition quality were presumably provided.
S.U.	SVD sniper rifle, Dragunov 7.62x54R with PSQ1 telescope	1963 to present	Semiauto, 10-round box magazine, 4X telescope calibrated to 1300 m range-estimating reticle	Semiauto operation range-finder reticle		Battery-powered illuminated reticle for night use, special filter for detecting active infrared sources, flash suppressor	A rifle specially designed for sniping rather than a modification of the standard rifle as are all others above.

TABLE 8. COMPARISON OF LIGHT MACHINE GUNS

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
U.S.	Thompson sub-machine gun, cal .45 M1928, M1 and M1A1	1928 thru WWII	Blowback operated, selective fire from open bolt, 20- or 30-round box magazine, 50-round drum on 1928 only	Rugged, reliable	Heavy, expensive to make, .45 cartridge lacks range for submachine gun use		Made famous (infamous) by its early use by gangsters and as an IRA terrorist weapon. Production ceased in 1943 when M3 became available. Still widely used in U.S. as a police weapon throughout world.
	Submachine gun, cal. 45 M3 and M3A1 (grease gun)	1942 to present	Blowback operated, full auto only from open bolt, 30-round box magazine	Cheap to make, relatively easy to control due to very low rate of fire	.45 cartridge lacks range for submachine gun	Silenced version available, 9 mm conversion parts available	Subsonic .45 cartridge' ideal for silencer adaption.
	Ingram M-10 (NAC 10), cal .45 and 9x19 mm	1970 to present	Blowback operated, selective fire from open bolt, 30-round box magazine	Very compact cheap to make, reliable	Hard to control due to high cycle rate and shape	Auxiliary screw-on silencer	Very effective silencer also provides much needed forward grip for better control.
	Hill sub-machine gun, 9x19 mm	1952 Exper.	Blowback operated, disposable plastic magazine lies parallel to gun above bolt	No protruding magazine	Complexity of turntable feeder	Ejection through bottom of pistol grip	More features possibly worthy of further development.
	XM177E2 sub-machine gun, 5.56x45 mm	1968 to present	Submachine gun version of M16A1 rifle having 11.5-inch barrel and telescopic butt	Very light, powerful cartridge provide long range	Excessive noise and flash, expensive cartridge cannot be silenced		Provides commonality with rifle, impossible to silence, noise level almost intolerable.

TABLE 8. (CONCLUDED)

Country of origin	Designation(s)	Period or use for issue	Design characteristics	Good features	Shortcomings	Special features	Remarks
S.U.	PPSH-41, 7.62x25 mm	1941 thru WWII	Blowback operated, selective fire from open bolt, 35-round box magazine or 71-round drum	Simple, reliable, cheap to make, good submachine gun cartridge	Drum difficult to load and carry, too high to silence, high cycle rate	Muzzle compensator	Most popular Soviet submachine gun, very widely used by infantry with tank as assault force. No longer used in USSR but common throughout world.
	PPS-43, 7.62x25 mm	1942 thru WWII	Blowback operated, fully automatic from open bolt, 35-round box magazine	Very cheap to make, simple, reliable, effective		Folding stock muzzle compensator	Best submachine gun of WWII. No longer used in USSR but produced and used widely throughout world. Designer Sudayev died at young age (37) in 1946, ending promising career.
	AK47 and AKM with 7.62x39mm folding stock	1947 to present	Gas-operated, selective fire from open bolt, closed bolt, 30-round box	Powerful, effective to 800 m, semiauto	Heavy, expensive to make, hard to control in full auto fire		This version of AK has replace submachine gun conventional type in USSR.
Israel	UZI submachine gun, 9x29 mm	1951 to present	Blowback operated, selective fire from open bolt 23-, 32-, or 40-round box magazine	Compact, simple, reliable, safe	Rather heavy	Grip safety, folding stock, magazine in pistol grip	Widely used throughout ^{WORLD} including U.S. Secret Service, Colt has made adapters to allow firing Salvo Squeeze Bore 9 mm ammo with 3 projectiles per cartridge.
West Germany	Heckler and Koch MP5 SU 9x19 mm	1966 to present	Retarded blowback with roller delay, selective fire from closed bolt, 30-round box magazine	Accurate, silent (built in), relatively light	More complicated than necessary	Folding stock, 3-shot burst limiter, 4x telescope sight, starlight scope, active infrared scope, .22 conversion kit, blank fire device, spot-light sight	Excellent design. Reliable ^{ABLE} despite complexity. The silent version with starlight scope would be ideal for night commandos (or terrorists).

and 5.56x45. However, the muzzle speed of these cartridges is too high for them to be effectively silenced, and they are more powerful than needed.

The ideal cartridge for silencing is the current U.S. .45 APC, but its weight is excessive and the trajectory too curved for a 200-m weapon. The 9-mm NATO cartridge ($V_0 = 1300$ ft/s with 115 grain bullet) can be silenced effectively either by using a heavier bullet to reduce velocity to subsonic (as in the MAC 10) or venting the barrel to reduce its power for the silent role (as in the MP-5 SD).

Historically, the pistol cartridge of the using country has been common with that of the SMG to simplify logistics. This is not always an overriding consideration, since optimum solutions for both these weapon requirements may require different rounds.

For some missions, the roles of the submachine gun and the personal defense weapon may be combined by using a mini-submachine gun for the latter, and adding a silencer and/or auxiliary stock as required.

ARMOR-PIERCING RIFLE

During WWI the development of the tank and the use by the Allies of armor-protected machine guns in the trenches led the Germans to develop a 13-mm bolt action rifle to penetrate light armor up to 3/4 inch thick. At the same time, the French developed a tiny, low-velocity, 37-mm cannon mounted on a machine gun tripod for the same purpose. Between the world wars, the Soviets developed a series of antitank armor-piercing rifles for the 14.5-mm round, to be used later in their KPV heavy machine gun.

The rifle was first designed for single-shot bolt action but finally evolved to a semiautomatic three-shot configuration

weighing about 45 lb. It was fired from the shoulder using a bipod mount. The ammunition could pierce armor up to 30 mm thick. Despite the weight and heavy recoil, this weapon was widely used in early WWII and was effective against the light armor used by the Germans. By the end of WWII it was obsolescent, and no similar weapon is now used in any Communist Bloc country. The rifle is nevertheless quite capable of devastating the U.S. M113 APC. The U.S. approach during this time was the shoulder-fired antitank rocket (bazooka).

Although somewhat similar rifles were developed in Germany, the United Kingdom and Poland, they were not as good nor as widely used; and nothing more was done on the concept until the late 1960s when the Defense Advanced Research Projects Agency sponsored development of a .50-cal flechette rifle. It fired a heavy metal depleted uranium hypervelocity flechette capable of penetrating 50 mm of armor with considerable incendiary effect beyond. The rifle weighed only 25 lb, so the recoil was exceptionally severe but tolerable. The ammunition gave poor accuracy which tended to defeat the purpose. Development was shelved when the U.S. involvement in Vietnam ended.

MILITARY SHOTGUNS

The use of shotguns by military forces has largely been confined to the United States. In general, shotguns have been used when circumstances warranted it, such as the Philippine insurrection, the trench raids of WWI, and in the tropical jungles of WWII and Vietnam. The guns in all cases were versions of the police riot pump or semiautomatic shotguns, modified to provide a handguard over the barrel and a bayonet lug where possible. Notable examples were the exposed hammer Winchester M1897, the hammerless Winchester Model 12, the Remington Model 11 semiautomatic (Browning), and the Remington 870 pump.

The standard military load has historically been 12-gauge 00 buckshot. Each shell contains nine lead balls approximately .33 inch in diameter fired at 1325 ft/s ($KE = 236$ ft-lb each). Velocity is lost rapidly, and the effective range from both energy and dispersion limits is about 60 m. A No. 4 buckshot load (27 lead balls .24-in dia) has been used; but despite its greater hit probability due to more pellets, it has not been proven lethal in most cases.

In the 1960s, various flechette loads were developed. A typical one fires 20 steel darts of ~7.5 grains weight at ~2000 ft/s. They are not notably more effective than buckshot although occasional long-range kills are observed. Other military 12-gauge loads include an Argentine-developed tracer, incendiary, slugs, high-explosive, and nonlethal loads for riot control.

It should be noted that even current body armor can defeat most buckshot. If it were to be used more widely, the effectiveness of shotguns could be greatly reduced.

The development potential for both shotguns and their ammunition is great. Existing shotguns have limited-capacity tubular magazines that are slow to reload. The mechanisms are not resistant to severe environments such as dust and salt water. The technology exists to build selective fire shotguns with either box magazines, drum or belt feeds. Notable prototypes already in existence include the Atchisson assault shotgun with a 20-round drum and the USN Childers machine shotgun with alternate box and belt feeds. Ammunition developments could include improved shot flechettes and high-explosive rounds, and special-purpose types such as flares, smoke and tear gas as made for the 40-mm grenade launchers.

The elimination of plastic cases in favor of brass or aluminum might avoid excessive chamber fouling in automatic

shotguns and its adverse effect on reliability. Combining the small grenade launcher and shotgun requirements appears feasible without significant sacrifice in performance of either type.

HAND-HELD GRENADE LAUNCHERS

WWI and II saw the use of explosive grenades fired from launchers attached to the muzzle of rifles using a special blank cartridge in the rifle. Booster cartridges inserted into the tail of the grenade were sometimes used to increase range. Recoil forces were frequently hard on both the rifle and the shooter and accuracy was not very good with the auxiliary sights provided. After WWII many foreign armies built the grenade launcher into the rifle muzzle and provided improved sights.

In the 1950s, the United States developed the 40-mm grenade and M79 launcher to fire it. This was a single-shot rifle, the barrel of which tipped up to load. The 6-oz grenade contained 1.25 oz of high explosives, and the fragments are 1-in lengths of wire from a coil in the body with notches at intervals. The impact fuze is armed by spin 50 ft from launch. The burst radius for 50 percent casualties is 5 ft, but the minimum safe range is 30 yd. Since velocity is only 250 ft/s, the range is only 375 yd and unless the exact range is known, accuracy is poor because of the curved trajectory beyond 100 yd. During Vietnam, a launcher for these grenades was developed for attachment to the M16 rifle. It was a single-shot with its own separate trigger and sights. It severely compromised the primary purpose of the rifle. Late in the Vietnam War a selective fire launcher (XM74) was introduced which was capable of hand-held or tripod use. It could also fire a higher velocity round with more range. Smoke, tear gas, shot and flare rounds are also available for all these launchers.

The requirement for a 30-mm automatic grenade launcher indicates continuing interest in such weapons by the U.S. military. The 300-m range is still probably unrealistically long but is achievable in a weapon of reasonable recoil and weight. It should probably have an optical rangefinder built in.


It may be feasible to make this same weapon fire shot salvoes and thus make it fit the selective fire shotgun requirement as well. Separate barrels would probably be necessary.

The Soviets have no equivalent weapon. They use single-shot recoilless grenade launchers (such as the RPG-7) instead. Intended as an antitank weapon, the RPG-7 has been employed against personnel by terrorists on numerous occasions. The range is 500 m, aided by a rocket booster. The blast effect of high explosives in these small grenades is minimal; the fragments are the kill mechanism.

AUTHOR'S OBSERVATIONS

Based on the foregoing survey, the author concludes that:

1. Neither the United States, the Soviet Union, nor any other major country has fielded small arms remarkably better than any other; nor has any single approach to small arms development been shown to be the best.
2. The personal defense weapon requirements can probably be combined with that for the SMG by using a selective fire machine pistol and adding a folding or detachable stock and/or silencer as appropriate.
3. The infantry assault rifle should be considered obsolescent and eventually replaced by the belt-fed SAW.

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4. The sniper rifle should be integral to the squad with training in its use, ^{limited} to a few of the most promising members.
 5. The requirements for the advanced shotgun and small grenade launcher should be combined into one weapon, and it should be issued on the basis of a few per squad. The grenade launcher should not be mounted on the rifle or SAW.
 6. A laser rangefinder would be a very useful improvement for sniper rifles, mounted machine guns, and grenade launchers.
 7. There is considerable room for product improvement in many existing systems in the field of weight reduction through the use of aluminum, titanium, beryllium and plastic replacing steel. The only penalty is increased cost.

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